PICKBOT

NOOR AZLAN BIN NORALAM

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Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang

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ABSTRACT

The final year project is to design and developed hardware pickbot which can assign a task to pick and place an object. As we know, commonly human can't work efficiently in along period without neglecting emotion and fatigue. In this project, Pickbot will help human to work with efficient and make a less mistake and also replace human to pick and place object in crucial corner. This pickbot project refers to arm robot that is controlled using microcontroller. In this project, an electrical actuator will be used which is servo motor. This actuator is suitable for this project because the angle movement of servo motor can be controlled. This project involved three main parts to be developed; which are hardware, circuit and software. The hardware parts are consists is the material that are used to build the robot and the design which is the suitable material for this pickbot. The circuit part consists of the microcontroller circuit, because the microcontroller is known as a brain of this robot. All the movement of the robot will be assigned by using microcontroller. The software part is to design the programming that will be used to assign an angle of movement for each servo motor to pick and place the object.

CHAPTER 1

INTRODUCTION

1.0 Introduction

The productivity and a quality product is the first element people in industry move forwards. The pressing need is to increased productivity and delivery of product of uniform quality, industry is turning more and more toward computer based automation. At this time, a special purpose machine designed to perform predetermined function in manufacturing process carries most automated tasks. Robot is one of an example of the technology computer based automation that produces by human.

A robot is a mechanical or virtual, artificial agent. A robot is usually an electro-mechanical system, which, by its appearance or movements, conveys a sense that it has intent or agency of its own. According to the Robot Institute of America (1979) a robot is define as 'A reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks' [1]. The word robot can refer to both physical robots

and virtual software agents, but the latter are often referred to as bots [2]. According to the Karel Capek the first person use term ‘robot’, the industrial robot was design to assist human being and not to replace them. There is so many type of robot; one of the types is industrial robot. Industrial robot is a programmable and manipulate designed to move materials, parts tools, or specialized devices through variable programmed motions for performance of a variety of tasks [3]**.**

This project is build because commonly human cannot work efficiently in along period without neglecting emotion and fatigue. Human also have a limitation to execute picking and placing object in crucial corner. In this project, Pickbot will help human to work with efficient and make a less mistake also replace human to pick and place object in crucial corner.

1.1 Objectives

The main of objectives of this project are to:

i. Design a pickbot using microcontroller
ii. Design the pickbot that able to pick and place square object

1.2 Scope of the Project

Generally, the scope of this pickbot project is to design a pickbot using the microcontroller. Figure 1 is about the block diagram of this pickbot project. Main part of this pickbot project is to build and design chassis robot using a suitable material. The microcontroller as brains in this project will be interfaced with the input and output hardware. Input hardware for this project is a switch and the output hardware is servomotor as actuators to drive a movement of the pickbot. A circuit design is required, this for electronics controlling device such as circuit for microcontroller, input, switching circuit and output, servo motor circuit. Software (programming) for microcontroller will be created to interface the hardware and the microcontroller. To complete the objective, pick and place square object, the hardware such circuit and pickbot chassis will be integrated with the software is required.

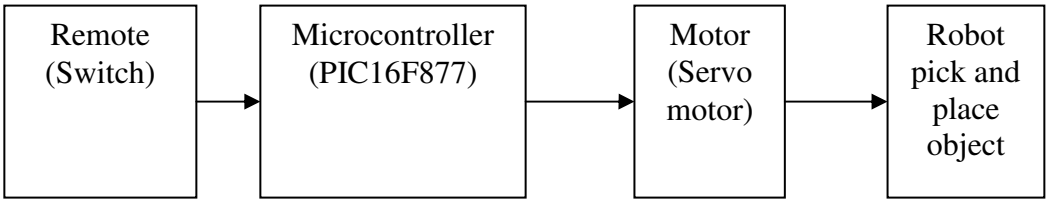


Figure 1.1: Block diagram of pickbot project

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

To build this project successful, some studies and information gathering has been done. All of this information is very useful as a guide in doing this project. This information is fetching from many sources such as books, article, journal and internet sources. The studies and gathering information based on some major component and topic that related to the project that will be used in project such hardware and software.

2.1 Pickbot and Industrial Robot

Pickbot is one of the industrial robot that commonly use in industries. Pickbots growing in complexity and their use in industry is becoming more widespread. The main

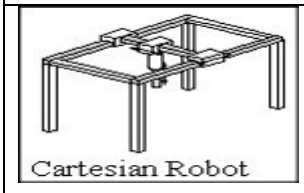
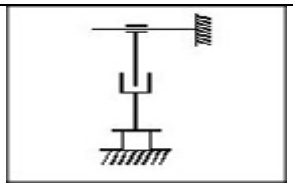
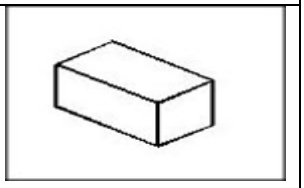
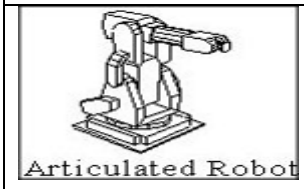
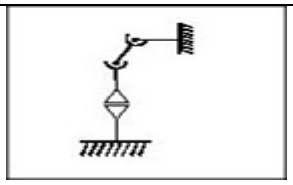
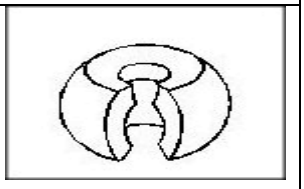
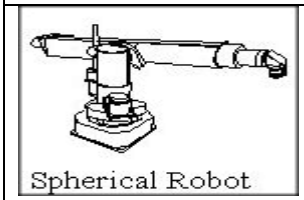
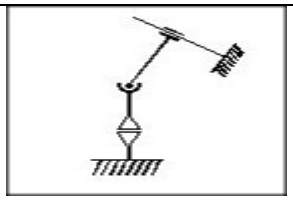
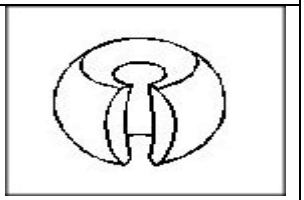
use of industrial robots has been in the automation of mass production industries, where the same, definable tasks must be performs repeatedly in exactly the same fashion. Car production is the primary example for the employment of large and complex robots for producing goods. Industrial robots are use in that process for the painting, welding and assembly of the cars. Industrial robots are good for such tasks because the tasks can be accurately defined and must be performed the same every time, with little need for feedback to control the exact process being performed. Industrial robots can be manufacture in a wide range of sizes and so can handle more tasks requiring heavy lifting than a human could [4]. The figure 2.1 below show the example of industrial robot used in factory.

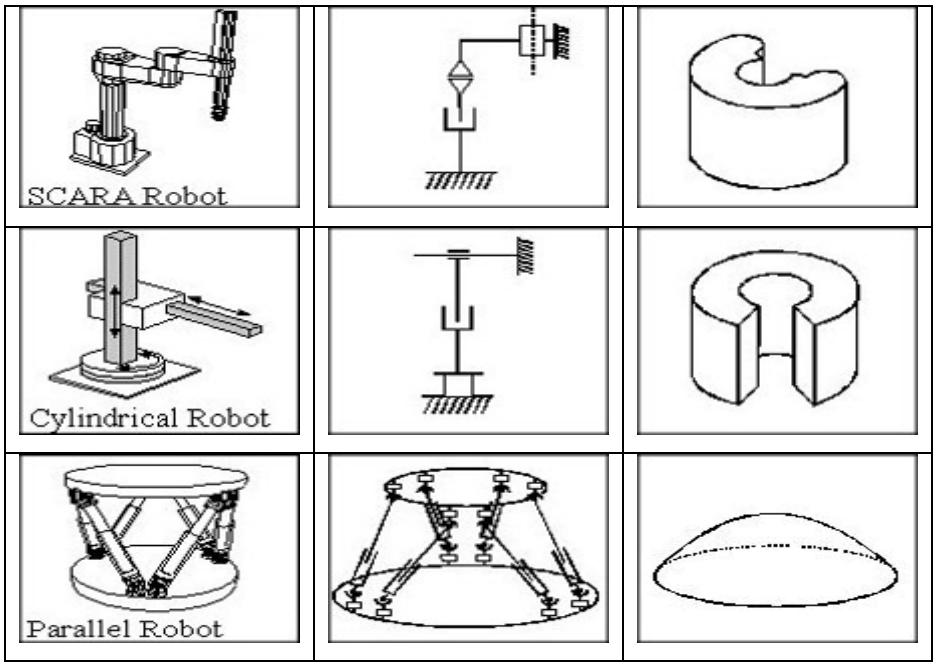
Figure 2.1: Industrial robot

2.1.1 Type of Industrial Robot

There is 6 types of industrial robot that commonly use in industrial. Cartesian robot, cylindrical robot, spherical robot, scara robot, articulated robot and parallel. Table 1 shows the kinematics' structure and work place of the industrial robot. Cartesian Robot/Gantry Robot is a robot whose arm three prismatic joint, whose axes are coincident with a Cartesian coordinator. Cylindrical robot is a robot whose axes form cylindrical coordinator systems. Spherical robot is a robot whose axis forms a polar coordinator system. Scara Robot is a robot that has two parallel rotary joints to provide compliance in a plane. Articulated robot is a robot whose arm has at least three rotary joints. Parallel robot is robot whose arms have concurrent prismatic or rotary joints [5].

Table 2.1: Type of industrial robot

Robot	Kinematics Structure	Workplace
 Cartesian Robot		
 Articulated Robot		
 Spherical Robot		



2.2 Motor

An electrical motor is defined as a motor that converts electrical energy to a mechanical energy to do work. It allows electric power to be used to run machinery. A motor basically, connected to a source of electrical power develops a twisting effort, that usually rotates the shaft of the motor. When this shaft connected, belted, or geared to a machine, it drives the machine to do a work. There are two types an electrical motor: Direct Current motor (DC motor), Alternating Current Motor (AC motor) and Universal Motor (can operate AC and DC current) [6].

2.2.1 Advantages of Servo Motor

A servomechanism, or servo, is a device used to provide control of a desired operation through the use of feedback [7]. The servo family is further divided into AC and DC types. A servo motor can be either DC or AC, and is usually comprised of the drive section and the resolves/encoder. An AC servo had the advantage of being able to handle much higher current surges than a DC, as the DC has brushes, which are the limiting factor in this case. Servo motor is a motor used for motion control in robot, hard disc drives and another application. Generally, servo motor is design more like an alternator than a standard motor; most servos need special control circuitry to make them rotate electrically. Some can be use in reverse to generate alternating current. Figure 2.2 shows the servo motor model Hitec Hs-422.

Figure 2.2: Hitec Hs-422

The advantages using servo motor than stepper motor is much smoother in motion than a comparable stepper, and will have a much higher resolution for position control. Steppers, on the other hand, have economy as an advantage but the advantages using servo motor over stepper motor is high intermittent torque, high speeds, work well for velocity control, available in all sizes and work in quiet [8].

2.2.2 How does servo motor work

Servos are controlled by sending them a pulse of variable width. The control wire is used to send this pulse. The parameters for this pulse are that it has a minimum pulse, a maximum pulse, and a repetition rate. Given the rotation constraints of the servo, neutral is defined to be the position where the servo has exactly the same amount of potential rotation in the clockwise direction as it does in the counter clockwise direction. It is important to note that different servos will have different constraints on their rotation but they all have a neutral position, and that position is always around 1.5 milliseconds (ms)[9]. Figure 2.3 show the graphical view of servo motor positioning.

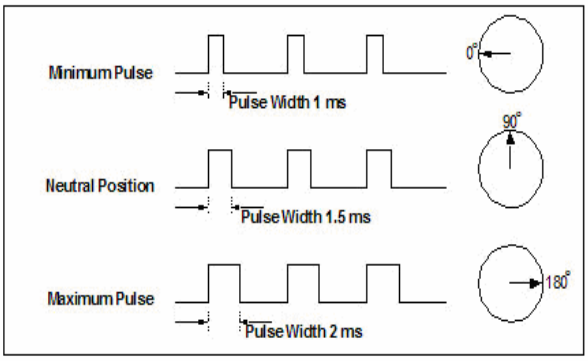


Figure 2.3: Graphic view of servo positioning

The angle is determined by the duration of a pulse that is applied to the control wire. This is called Pulse width Modulation. The servo expects to see a pulse every 20 ms. The length of the pulse will determine how far the motor turns. For example, a 1.5 ms pulse will make the motor turn to the 90 degree position (neutral position).

When these servos are commanded to move they will move to the position and hold that position. If an external force pushes against the servo while the servo is

holding a position, the servo will resist from moving out of that position. The maximum amount of force the servo can exert is the torque rating of the servo. Servos will not hold their position forever though; the position pulse must be repeated to instruct the servo to stay in position.

When a pulse is sent to a servo that is less than 1.5 ms the servo rotates to a position and holds its output shaft some number of degrees counterclockwise from the neutral point. When the pulse is wider than 1.5 ms the opposite occurs. The minimal width and the maximum width of pulse that will command the servo to turn to a valid position are functions of each servo. Different brands, and even different servos of the same brand, will have different maximum and minimums. Generally the minimum pulse will be about 1 ms wide and the maximum pulse will be 2 ms wide.

2.3 Microcontroller

A microcontroller is an inexpensive single-chip computer. Single-chip means that the entire computer system lies within the confines of the integrated circuit. The microcontrollers existing on the encapsulated silver of silicon have features and similarities to our standard personal computers. Primarily, the microcontroller is capable of storing and running a program [9]. Microcontrollers are frequently used in automatically controlled products and devices, such as automobile engine control systems, office machines, appliances, power tools, and toys. By reducing the size, cost, and power consumption compared to a design using a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to electronically control many more processes.

2.3.1 Advantages Using Microcontroller over Microprocessor

A microcontroller (MCU) is a computer-on-a-chip. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor. The only difference between a microcontroller and a microprocessor is that a microprocessor has three parts - ALU, Control Unit and registers (like memory), while the microcontroller has additional elements like ROM, RAM etc.

The advantage of using MCU is a microcontroller is an inexpensive single-chip computer. Single-chip means that the entire computer system lies within the confines of the integrated circuit. The microcontroller contains a central processing unit (CPU), random-access memory (RAM), read-only memory (ROM), electrical erasable programmable read-only memory (EEPROM), input/output (I/O) lines, serial and parallel ports, timer and other built-in peripherals, such as ADC (analog-digital-converter) and DAC (digital analog converters. The most common microcontroller use is PIC (Microchip), MC68HC16 (Motorola), etc.

2.3.2 Microcontroller PIC16F877 Features

PIC16F877 is one of the Microchip technology company products [10]. This MCU is the most suitable for this project. Figure 2.4 shows the block diagram of PIC16F877 microcontroller, Figure 2.5 shows the specification pin of the microchip, PIC16F877. The features or specification that have in this MCU PIC16F877 is high performance RISC CPU and all cycle instruction except for program branches which is 2 cycle. Operating speed DC-20MHZ clock input. Data memory for EEPROM built in is 256 X 8 byte. The special features in this PIC16F877 is Oscillator selection, have 4 reset

way, Power-on Reset (POR) , Power-up Timer (PWRT), Oscillator Start-up Timer (OST) and Brown Out Reset (BOR). Other specialty is, this microcontroller have Interrupt, watchdog timer, Sleep, code protection and ID location [11].

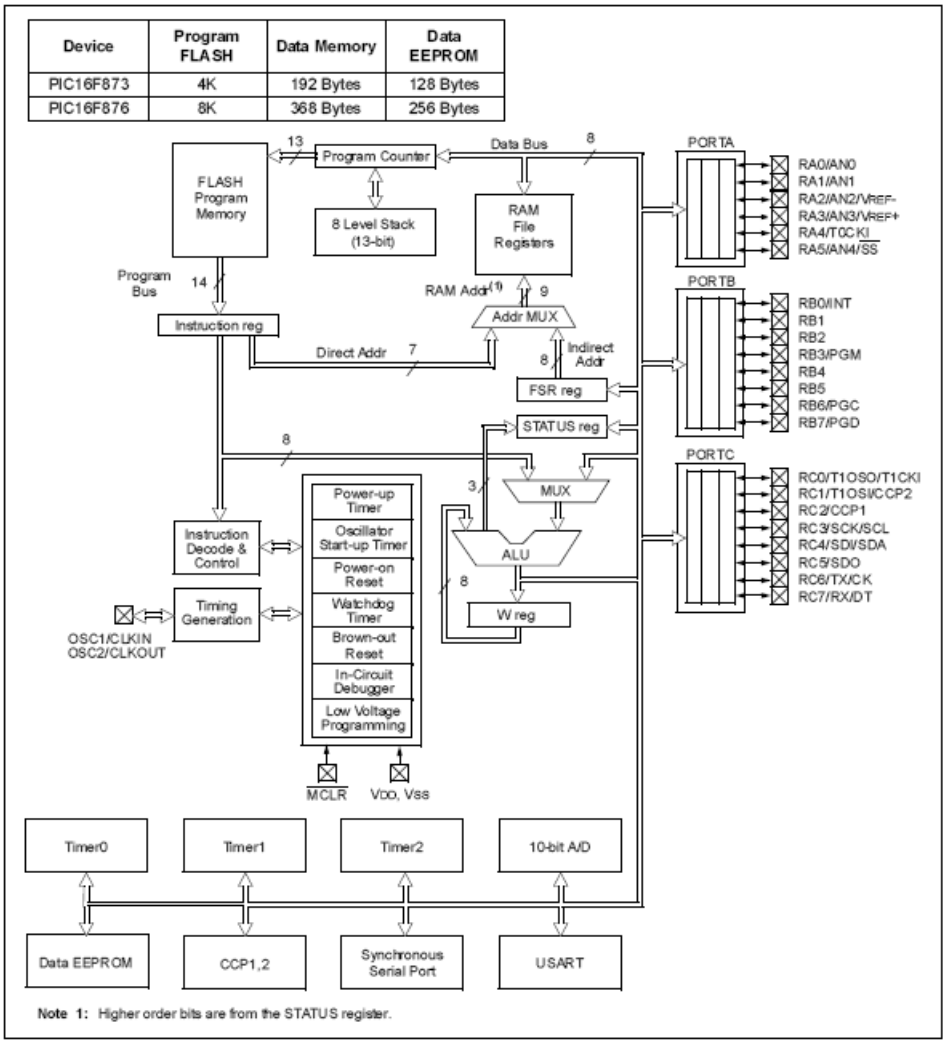


Figure 2.4: PIC16F877 block diagram

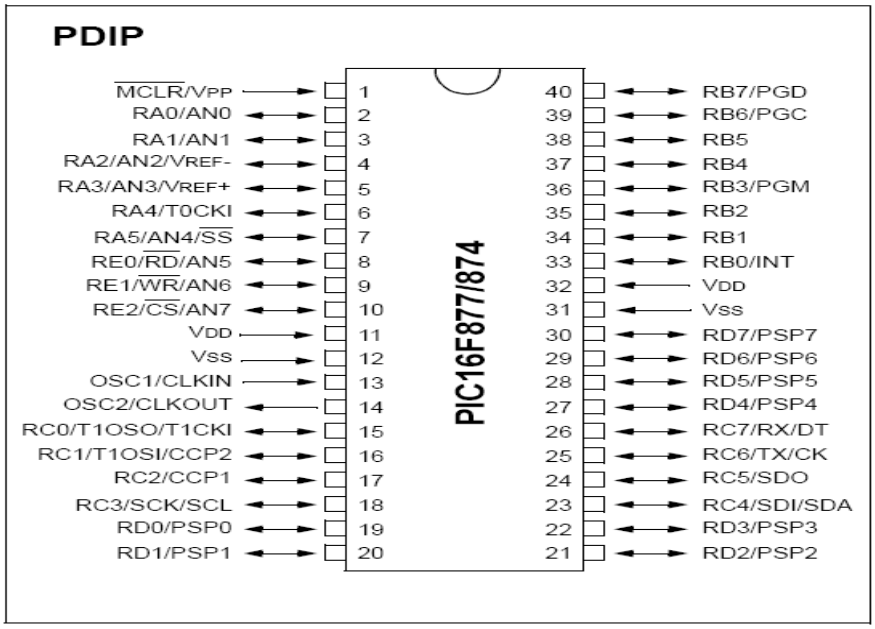


Figure 2.5: 40 pin PIC16F877

2.3.3 USB Programmer

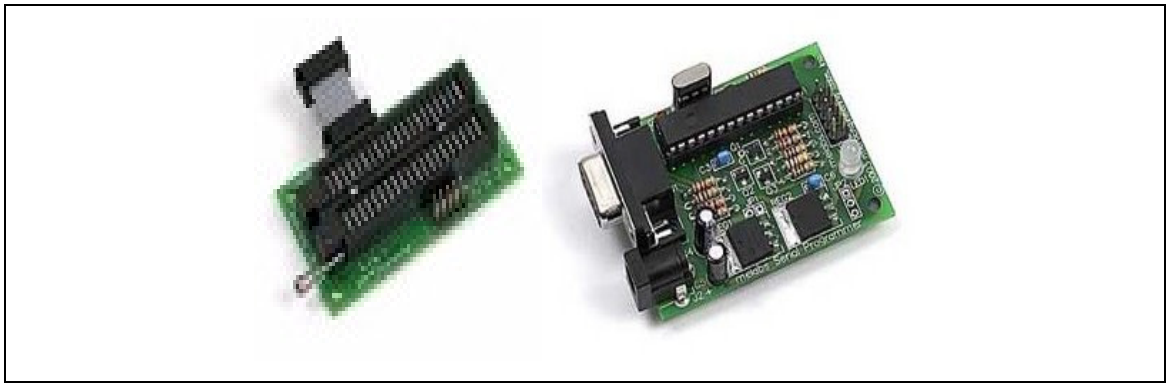


Figure 2.6: Melab U2 programmer

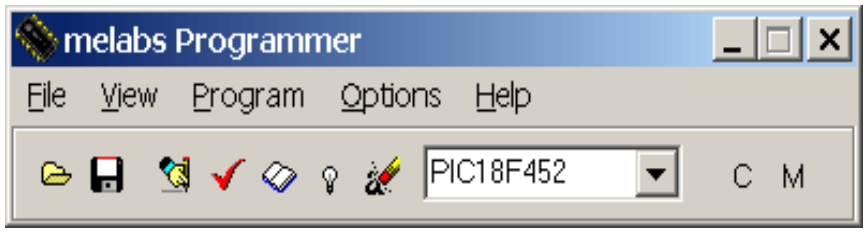


Figure 2.7**:** Melabs Programmer toolbar

Programmer uses a serial port to interface to the computer. This makes it compatible with computers that don't have parallel ports. It also allows the use of a USB-to-Serial adapter for those computers that only have USB ports. Figure 2.6 show the picture of MelabsU2 Programmer. The programmer board is specifically designed for In-Circuit Serial Programming (ICSP). An adapter is available to allow the programming of DIP-packaged PICs from 8 to 40 pins. The programmer is also compatible with the complete line of Programming Adapters. This allows user to program almost any ICSP-capable PIC in almost any package. The programmer board measures only 1.8" x 2.3". Power is supplied by a 15VDC, 500mA AC Adapter. A dual color LED indicates programmer status. The connection to the computer is via a standard 9-pin serial cable.

Some features of this programmer is it have a Fast serial operation at 115,200 bps, can be used with USB-to-Serial adapters, have dual-colour indicator shows ready/busy states, in-Circuit Serial Programming (ICSP) connector for interface to project board, full featured software included with support for all ICSP-capable PIC microcontrollers, compatible with Microchip HEX format files and with all Programming Adapters. The programmer includes software for Windows 98/Me/NT/2000/XP [10].This software will make sure the user to control the programmer and set the configuration bits on the PIC. The software may be run as a

standalone application or launched from most program editor/IDE packages like MicroCode Studio (same as installed in the computer at the FKEE lab).Figure 2.7 show the example melabs programmer toolbars.

The Serial Programmer software is compatible with the standard Microchip HEX format files and any assembler or compiler for PIC microcontrollers can be used to create the program, including MPASM, CCS C, PicBasic, or PicBasic Pro.The software allows user to set configuration bits on the PIC with an easy-to-use list of options and each configuration option is selectable in a drop-down list. Configuration data may be read from a hex file or from a PIC [10].The consolidated view-memory window function to view each section of memory in the PIC with a click and a right-click gives the choice of viewing ASCII, Decimal, or Hexadecimal. A formidable list of options allows customizing the way of interact with the software and all operation can be control for example what areas of the device are erased, programmed, and verified. Save mouse clicks with options like "Disable completion messages" and "Erase before programming". The programmer's firmware can be upgraded electronically with the click of the mouse [10].

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter explains all the methodologies for development of Pickbot robot. It gives review of all method that being used in designing and constructing this project. This chapter also explains in theory of how the circuit process as well as the components that will be use and the work flowchart.

Due to the project, several methods have to be implemented to make this project success and the experiment method was identified. By experimenting, the theories that have been searched are supported and make the project work physically, not just theories. By the way, research in several of sources act as a guide line to know which method is ideal and which are not suitable.

The procedure to complete this project begins with the data collection and literature review that have been done during first semester of the project. The study on circuitry of power supply, servo motor and microcontroller are important to select the right component and tools that has to be used.

3.1 Project Planning Schedule

Project planning Schedule is one of the important part during develop the project because will guide and shown the step during project development. Appendix A Show the Project Planning Schedule for “Projek Sarjana Muda 1” (PSM1) and “ Projek Sarjana Muda 2“ (PSM 2)

3.1.1 Flow Chart Description

There is some method that has been applied to make this project run smoothly and make this project work systematic. The flow chart will be used as a guide line to develop this pickbot. Figure 3.1 show the progress or the sequence of this project. From the flow chart, in order to complete this project, data collecting and gathering is needed. Collect the data and research mean collect the source from the books, journals, internet, website and so on which are related with the project as a reference. After literature review step there are 3 main steps are needed to complete this project. The 3 main steps are hardware development, circuit development and software development. The final Step is to integrate all the3 main parts to complete the pickbot project and archive the objective of this project

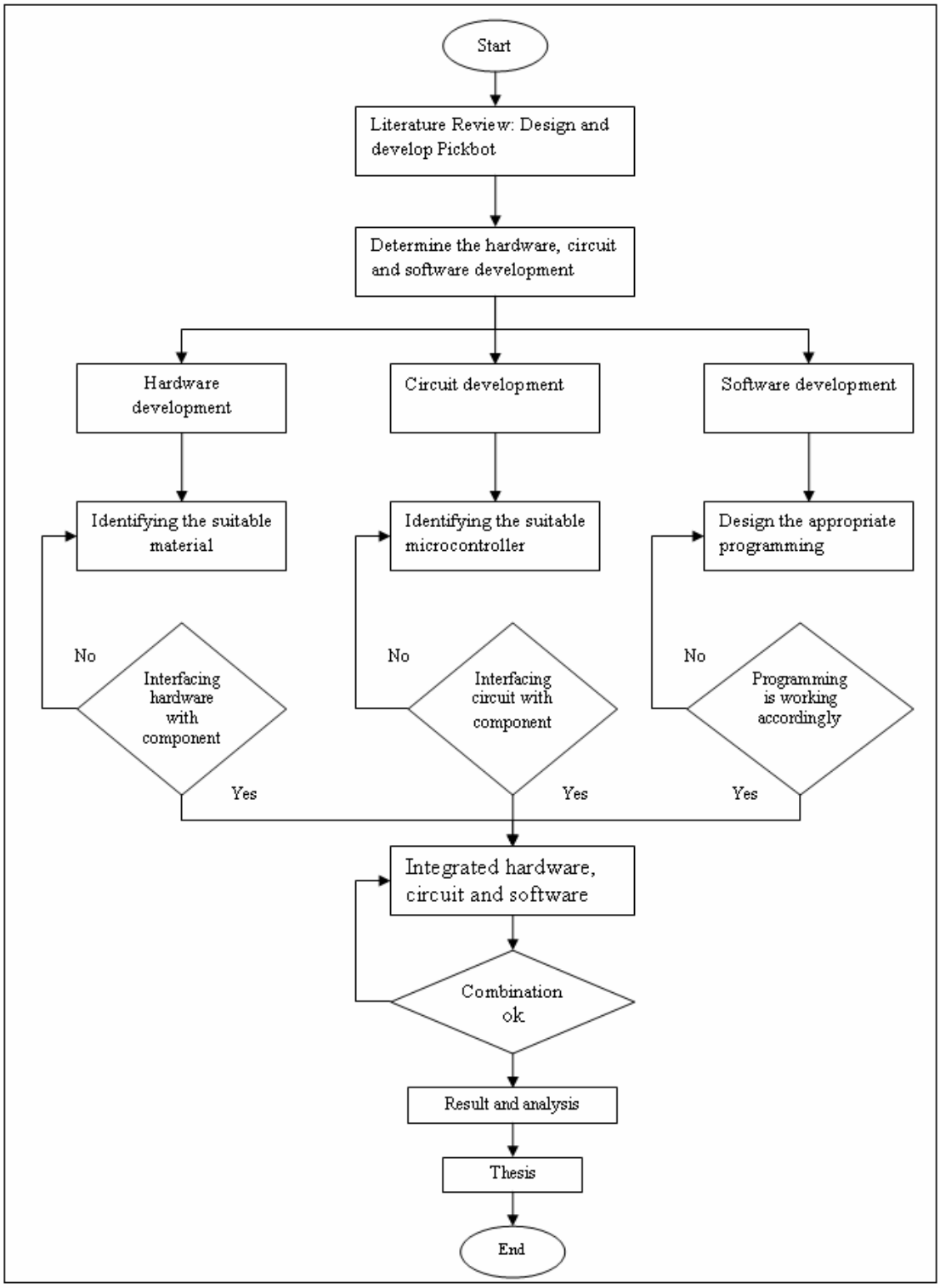


Figure 3.1: Flow chart of the pickbot project

3.2 Hardware Development

In fabricating a robot (hardware), the most important criteria that is need to take into consideration is the weight. The reason why weight is emphasized is the actuator that will be use is servomotor. Unlike the pneumatic and hydraulic actuators, electric actuators (servo motor) capable of lifting very low weight comparatively. For the hardware, must be low in weight to achieve high efficiency. The material for the hardware (body) which needs to be selected must be low in weight and high or moderate strength. The best material which meets all the need is acrylic.

3.2.1 Acrylic

In this hardware part, acrylic has been chosen because this material is a useful, clear plastic that resembles glass, but has properties that make it superior to glass in many ways. Acrylic is used to make various products, such as shower doors, bath enclosures, windows and skylights. It is chosen over glass for many reasons. It is many times stronger than glass, making it much more impact resistant and therefore safer. Falling against an acrylic shower door will not likely break it. Baseballs that crash through glass windows will, in most cases, bounce off acrylic windows. Acrylic also insulates better than glass, potentially saving on heating bills.

3.2.2 Design Specification

Pickbot robot consist 4 main parts that need to build. The part is base, lower arm, upper arm and gripper. Each part has a servo motor as an actuator to move the pickbot robot. Table 3.1 shows the specification of pickbot project. Figure 3.2 above show the technical view of the pickbot that going to be developed. The blue colour shows the actuator (servo motor). The yellow colour shows the base of the pickbot. The green colour is the lower and upper arm. The pink colour is the gripper.

Table 3.1: Specification of pickbot project

Part	Length	Weight
Stand/base	5 inch	100 g
Lower arm	8 inch	80 g
Upper arm	2 inch	20 g
Gripper	5 inch	50 g

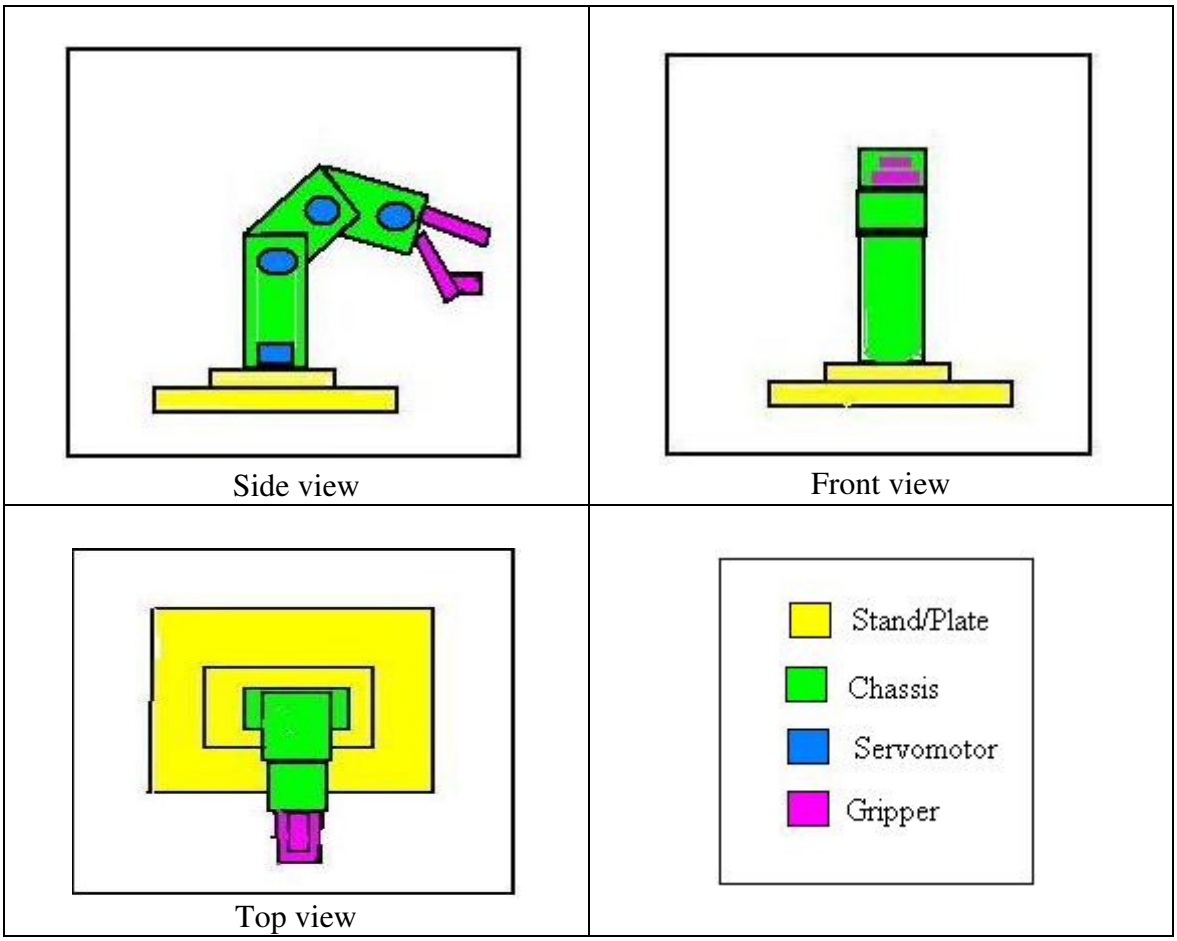


Figure 3.2: The design for pickbot project

3.2.3 Circuit Development

The important thing for circuit development is need to chose the component that will be used to build the main circuit. The component is chosen because of specification that will suitable for the project. This research is doing by literature review in previous chapter. Table 3.2 below show the list component that will be used to developed this project.

Table 3.2: List of component

Component	Explaination / specification	Company
PIC 16F877	Microcontroller: To control the input and output	Microchip Technology inc.
Resistor	10 K ohm	
voltage regulator	Give exact value +5v to microcontroller	7805CT
capacitor	100uF (4 quantity), 22uF (2 quantity)	
Reset switch	For reset application	
Crystal 20Mhz	Give the signal clock to microcontroller	
Switch (SPWT)	Input switch for this pickbot project	

This pickbot project has two main circuits that need to be developed. This two main circuit is depending on each other. The circuits that need to build are:

- Supply circuit
- Main circuit

3.3.1 Supply Circuit

Figure 3.3 below shows the supply circuit for this project. This circuit shows the diagram to perform +5V Dc supply. The source of this supply circuit is +9V Dc .Voltage regulator 7805CT is use to get the stable +5V Dc supply. This is because the microcontroller PIC16F877 chip operating voltage range is 2.0V to 5.5V and current 25mA. “heatsink” is used in voltage regulator to make sure the chip is operating in maximum temperature.

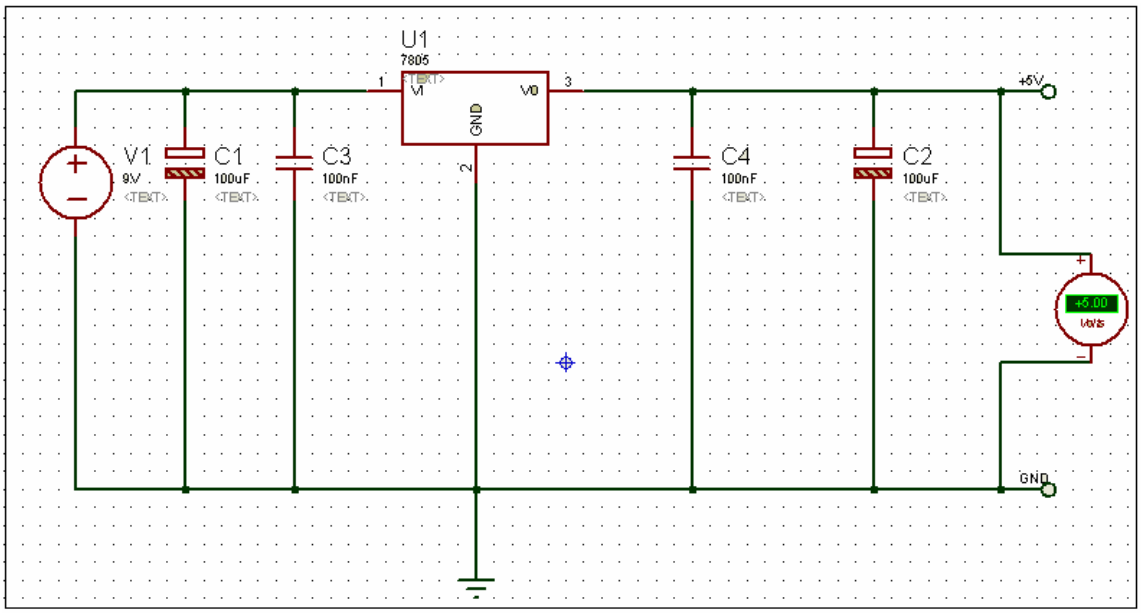


Figure 3.3: Supply circuit

3.3.2 Controller Circuit

The controller circuit needed +5V dc to operating. This explain in supply circuit above. Figure 3.4 shows the controller circuit The controller circuit is consist the microcontroller PIC16F877 chip. There are 5 port in this microcontroller that can be use as input and output port, port A, port B, port C, port D and port E. To assign the port become output and input, it must using proggramming. This main circuit will control the servo motor movement. In this project servo motor will be connected to port C which is pin 15,16,17,and 18 in microcontroller chip. One switch will be used as a input to this project. This switch will be assign in port B which is pin 33 in microcontroller chip.